STRIKE ONE! ALUMINUM. STRIKE TWO! MAPLE. WILL EAB BE STRIKE THREE?

Brian Boltz and Jan Wiedenbeck

Larimer & Norton (BB), Timber Division of Hillerich & Bradsby,1
1 Hemlock St., Warren, PA 16365; and
U.S. Forest Service, Northern Research Station (JW),
241 Mercer Springs Rd., Princeton, WV 24740. JW is corresponding author;
to contact, call (304) 431-2708 or email at jwiedenbeck@fs.fed.us.

Abstract.—Baseball bats made out of white ash (*Fraxinus americana* L.) have been the standard for professional baseball since the beginning of the game in 1849. Until the mid- to late-1970s, ash was the principal material used for all baseball (and softball) bats – major league, minor league, adult, and youth. The market share of baseball bats made from wood eroded precipitously in the late 1970s and early 1980s as a result of the introduction of aluminum bats. Wooden bats now constitute less than 10 percent of bat production and sales.

Despite reduced demand for ash in bat production, the emerald ash borer's (EAB) presence became a threat to manufacturers of ash baseball blanks (termed "billets") in July 2009 with the first substantiation of the presence of EAB in southwestern New York. Billet manufacturers are having to shift their ash procurement regions, and contingency plans for using alternate species in wood bat manufacture are being formulated.

ALUMINUM BATS ... STRIKE ONE!

The aluminum bat arrived on the scene in the 1970s (although originally patented in 1924; Sheldon 2008) and quickly gained a significant share of the baseball bat market. Within a few years, the majority of youth bats, which make up about 33 percent of the overall bat market, were made out of aluminum. Likewise, the majority of adult bats—bats used by high school and college players—also are made of aluminum (or a metal alloy) today. Considering all levels of baseball and softball, non-wood bats (aluminum, metal alloys, and composites) now compose 90 to 95 percent of annual bat sales (personal communication with M. May of the Sporting Goods Manufacturers Association, Nov. 17, 2009).

The high-end and most widely recognized market for wooden bats is professional baseball–the major and minor leagues. Baseball bats manufactured for professional baseball constitute an estimated 18 percent of the wood bat market. Retail bat sales, however, represent a much larger proportion of the wooden bat market (65 percent). These sales are to youth and little league players who have aspirations of advancing to professional baseball and need to learn how to hit with a wooden bat. In addition, a few adult baseball leagues that mandate the use of wood bats can be found scattered around the country. These leagues reportedly have been gaining popularity (Wikipedia contributors 2009). Today, total annual demand for wood bats is about 1.3 million.

MAPLE BATS … STRIKE TWO!

The species of wood used for bats were quite diverse in the early years of the game of baseball, but for decades white ash has been the dominant material. Oak (*Quercus* spp.) was used by a handful of players during the early days of baseball when ball players made their own bats or had them made by a local woodworker. Babe Ruth and a few other major league players during the first half of the 20th century used hickory (*Carya* spp.), a denser, heavier wood than ash. Both hickory and oak were too heavy to swing fast and thus fell into disfavor. For major and minor leaguers, adults, and youth, ash was the material of choice for all baseball and softball bats until the mid- to late-1970s. Ash, with a specific gravity of 0.55 (green moisture content basis; Forest Products Laboratory 1999), is a strong, resilient, straight-grained wood with excellent surface hardness.

As recently as 1998, maple (specifically sugar or "rock" maple; *Acer saccharum* Marsh) bats were essentially non-existent. The maple bat's first appearance in a major league game was in 1997. By 1998 a handful of players were using the maple bat. The new bat went from being a curiosity to being a known entity in just 2 years as major league players, always seeking opportunities that might gain them a few more points on their batting average, tested maple bats made to their specifications. The use of maple bats by a couple of big-name players, Conseco and Bonds, helped cultivate interest in maple bats throughout professional baseball.

In Major League Baseball (MLB), an estimated 25 percent of the bats were maple bats in 2004. The high rate of adoption of maple for baseball bats by major league players continued for several years but appears to have leveled off since 2008. In 2009-2010, it is estimated that 50 percent of the bats used in MLB are made of sugar maple. This percentage is down slightly (perhaps 5 percent) from the peak usage rate seen in 2008.

The decline in use of maple baseball bats by major league players is associated with heightened concern about the risks associated with the number and nature of broken maple bats. During a 3-month period in 2008, all bats that cracked or broke during MLB games were collected for analysis. It was found that bats made of maple broke into multiple pieces (as opposed to just cracking or delaminating) much more frequently than ash. Analysis of these breaks showed that the grain was not straight in many of the failed maple bats, causing a high percentage of the breaks (Major League Baseball Association 2008). Nine new rules governing baseball bat manufacture were adopted by MLB before the 2009 season to reduce this risk. Early reports indicate that the incidence of broken bats during the 2009 season was reduced by 30 percent compared to 2008 (Glier 2009).

Two Strikes but Still Swinging … Ash Baseball Bats

Ash remains the dominant species used for bats in the wider bat market (75 to 80 percent of wood bats) as baseball players in the minor leagues have not adopted maple bats to the same extent as major league players have. The difference in the market share held by maple versus ash between the major and minor/adult leagues is attributable, in part, to the higher price of maple bats. Maple bat prices are 25 to 40 percent higher than ash bats of a comparable style and quality. Not only are stumpage prices for the higher grades of sugar maple twice those of white ash in Pennsylvania and New York (New York State Department of Environmental Conservation 2009, The Pennsylvania State University 2009), but the volume of baseball bat blanks, known as "billets," recovered per log is 20 percent higher for ash than for maple.

Essentially all of the white ash harvested for the baseball bat market is harvested from a fairly narrow north-south zone that runs along the state line between New York and Pennsylvania. Common belief is that the ash resource to the south of this zone is not as hard as desired, and to the north the ash is too heavy to satisfy the weight distribution specifications sought by major league players. High-quality ash of the sort that can be used to make bats for players in MLB is straight-grained, with the horizontal grain deviation along the bottom 20 inches of the bat (the handle portion, which is most susceptible to breakage) not offset more than 1 inch. This high-quality ash wood also has consistent-width growth rings with 8 to 9 growth rings per inch being preferred. Only 6 to 7 percent of the billets produced from select ash logs procured from this zone of New York and Pennsylvania are of sufficiently high quality to produce baseball bats for MLB.

Larimer & Norton: Manufacturing Billets for America's Top Producer of Wood Bats

The history of Larimer & Norton (L&N), the timber and sawmill division of Hillerich & Bradsby (H&B), manufacturer of the Louisville Slugger, mirrors the history of the ash baseball bat.

In 1954, H&B acquired L&N, a sawmill company in northern Pennsylvania, to secure its access to ash billets for the manufacture of its wood baseball bats. The acquisition also gave H&B an added measure of quality control over its raw material. The vast majority of bat

manufacturers buy billets from multiple sources on the open market. H&B is one of the only bat manufacturers that make their own billets. In fact, all of the billets used by H&B to manufacture Louisville Slugger wood bats are produced by L&N.

In the mid-1970s, L&N was manufacturing 7 million ash billets per year at 11 sawmill operations, all but one of which were in the New York–Pennsylvania ash quality zone. Then aluminum entered the picture and L&N's production of ash billets dropped to about 1 million per year.

H&B did not turn its back on the aluminum bat market. In 1974 it entered the market, and in 1978 it began to manufacture aluminum bats at a plant in Ontario, CA. However, H&B has held fast to its commitment to be the premier wood bat manufacturer, and its wood bat product line is still considered the company's flagship business. While only 5 to 10 percent of all bats manufactured industry-wide are made of wood, 40 to 50 percent of the bats made by H&B are wooden.

As recently as 2004, L&N had 100+ employees, 6 sawmills, and a dimension operation that produced rough turnings, rectangular blanks, and moldings for sale to companies in other sectors of the wood products industry. Then maple, market globalization, and the recession began to complicate the marketplace and operating environment. The maple phenomenon has led L&N to shift some of its billet production away from white ash to sugar maple (ash to maple ratio is now 80:20). Today, L&N operates three sawmills in northern Pennsylvania with 35 employees and produces approximately 725,000 ash and maple billets per year.

A Field Trip to Larimer & Norton's Forest and Sawmill Operations

Ash billets are produced at Larimer & Norton's sawmills in Akeley, PA (north of Warren) and Troy, PA (north of Williamsport) while hard maple billets are produced at its sawmill in Galeton, PA (west of Wellsboro). The Akeley and Galeton mills also have dry kilns and billet finishing operations. Billets for adult and professional bats (both ash and maple) are dried and finished at the Akeley facility. The drying and finishing of billets for youth bats, which still make up approximately one-third of L&N's production, is carried out at the Galeton mill location.

L&N owns and manages 6,300 acres of forest land in the same region. The L&N forests currently provide a very small percentage of the log volume processed in the L&N mills—approximately 3 percent of L&N's annual log input. The L&N forests were heavily harvested in the 1960s and 1970s, so it will be another 10 to 20 years before the ash on these forests will be in the 15- to 17-inch diameter at breast height range, which will yield logs of sufficient size for manufacture into bats. Such logs should have small-end diameters of at least 11 inches and preferably 15 inches and larger.

L&N buys about 75 percent of its logs as "gate logs"—logs delivered directly to its three sawmills by loggers and neighboring mills that know what type and quality of ash or hard maple logs the L&N sawmills seek to buy. Stumpage sales are the source of approximately 22 percent of L&N's ash and maple logs with the remaining 3 percent obtained from company-owned forests. When L&N buys stumpage or harvests its own forests, it must resell the logs of other species. L&N has three foresters – two focused on procurement and one focused on forest land management.

Inside the Mill

If you have visited a sawmill producing lumber, your image of a sawmill is not an accurate portrayal of a sawmill producing billets for baseball bats. Logs arrive at the mill in 10- and 14-foot lengths. This is where the similarities with standard sawmill processing systems end. The logs are bucked (cut) to 40-inch lengths in the log yard. These short logs are not debarked before entering the mill, nor are they sawn. Rather, the breakdown process involves boring or turning on a lathe.

Producing billets using a lathe is the longstanding method used throughout the industry. L&N produces only 30 percent of its billets in this way. All maple billets and 60 percent of the ash billets are produced on a boring machine that is unique within the industry (Fig. 1). Overall, 70 percent of L&N's billets are produced on its four boring machines.

Figure 1.—Billet boring machine on which 70 percent of L&N's billets for baseball bats are produced.

The billets, at this point in the process referred to as "rough billets," are 3 inches in diameter (for adult and professional bats) and 40 inches in length. Depending on the diameter of the log, eight or more billets can be recovered from each of the 40-inch-long logs. Thus, on average, 24 billets are produced from 10-foot-long logs and 32 are produced from the 14-foot logs. Recoveries —the volume of usable rough billets produced, divided by the volume of the short log—are higher for ash than for maple. Ash recoveries typically range from 80 to 90 percent while maple recoveries range from 65 to 75 percent. Maple recoveries are lower because maple exhibits more internal defects than ash. This insufficient quality leads to a higher percentage of the rough maple billets being culled.

The rough billets are stacked for shipment and drying. Whereas in drying lumber, stickers are placed between layers to allow for air passage through the lumber stacks, stickers are not needed when drying billets. Maple and ash billets are dried together, but in both cases the billets are dried to a target moisture content range of 10 to 12 percent using a mild temperature schedule. Total drying time for each batch of billets, which consists of 11,000 pieces, is 28 to 30 days. The drying of ash billets is fairly straightforward as few drying- related defects arise. Maple billets can end check during drying, especially in the winter, so lower temperatures and longer drying times are necessary.

After drying, the billets are sent to a finish processing line where they are redoweled to a smaller size (down to 2.75 inches diameter for adult bats) and trimmed to 37 inches in length. At this point they are graded and weighed, then sorted into billet bundles based on these attributes (Fig. 2). The straightness of the grain is the most important quality factor. The slope of the grain cannot exceed 3 inches along the length of the billet. Grain straightness differences are evident when comparing the "Major League Quality" billet on the left and the "Low-end Retail" billet on the right in Figure 2.

All finished billets are shipped to the Louisville Slugger factory in Louisville, KY. The Galeton billet warehouse ships an average of 2 truckloads per month of billets for youth (and softball) bats. There are 10,000 billets per truckload. The Akeley warehouse ships an average of 6 truckloads of billets per month with 7,000 billets per truckload, sized and sorted for use in manufacturing adult and professional bats.

Figure 2.—Billet quality classes and grade-weight sorted bundles of finished billets awaiting shipment.

EMERALD ASH BORER THROWS ANOTHER CURVE AT ASH BATS—WILL THIS BE STRIKE THREE?

The emerald ash borer's (EAB) presence became a real and present hazard for ash billet manufacturers in July 2009. The first substantiation of the presence of EAB in the "ash quality zone" occurred in Cattaraugus County, NY. Owing to this discovery, Cattaraugus and Chautauqua Counties in the far southwestern region of New York now have EAB quarantines in place. Ash logs

can no longer be procured from these two counties by primary processors outside the quarantine zone.

For L&N, the adjustment process has begun. The two L&N mills that process ash are represented by the westernmost and southernmost star icons on the map in Figure 3. For these ash mills, the procurement zone is only 50 miles—this is the maximum economically feasible distance the sawmill can reach out for logs. For the Akeley ash mill, about 35 percent of its procurement zone is now quarantined. Consequently, the Akeley mill's procurement zone probably will have to expand out further, or the mill will have to offer a higher price for stumpage and logs available from within the 50-mile radius.

If when additional neighboring counties are affected and come under quarantine, more significant strategic adjustments will be required. A range of possibilities exists for L&N. Since L&N has three active mills and still owns one of its recently closed- down facilities, shifting maple production to the Akeley mill and ash production to one of the other facilities could be feasible for some length of time.

If EAB becomes widespread in the region and the counties in which the L&N mills are located come under the quarantine, ash logs will likely be abundant (for a few years) as forest landowners seek to harvest ash trees before they begin to die. The EAB compliance agreement into which producers will need to enter if they are to continue producing ash products will allow L&N to ship its billets (which have been debarked and dried) through other states to the Louisville Slugger plant in Kentucky.

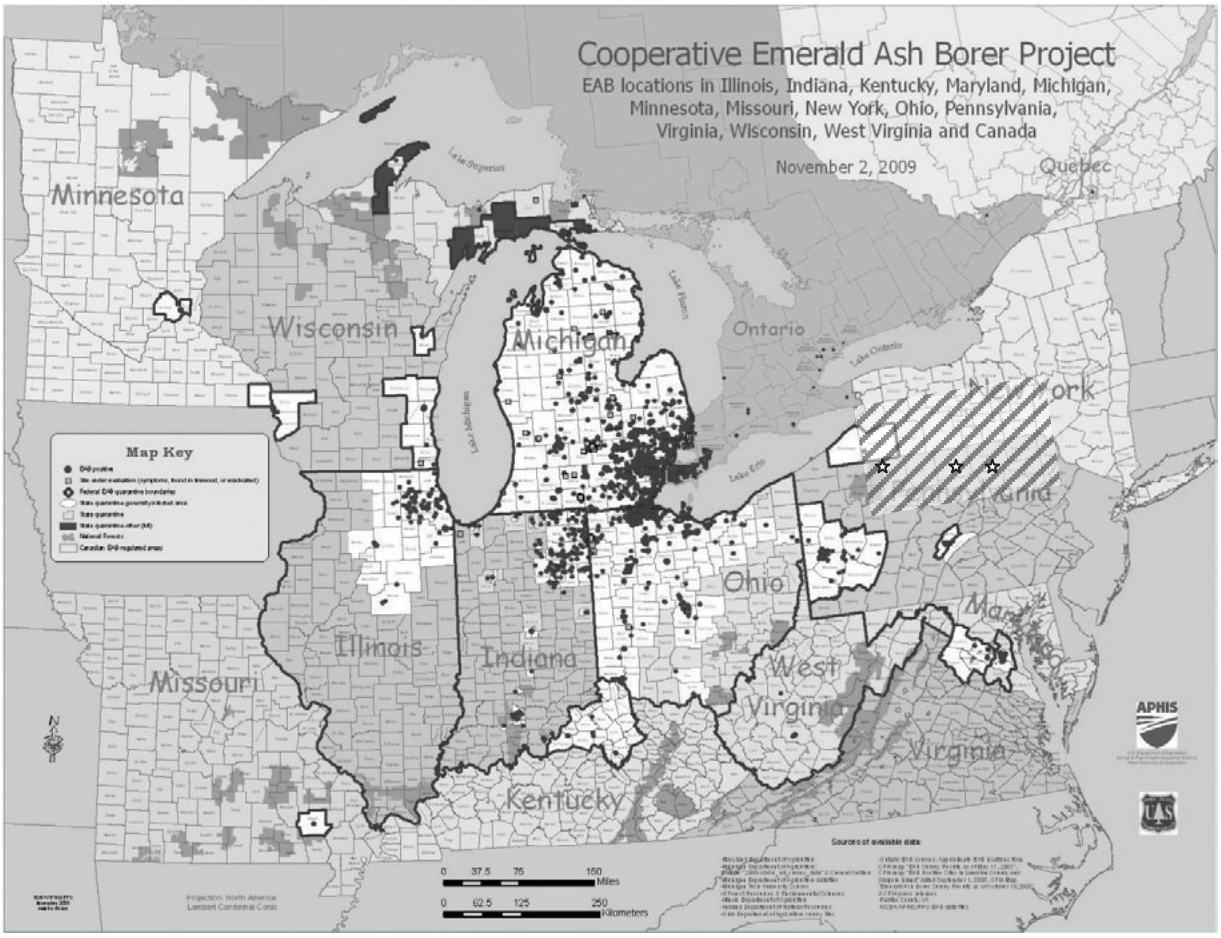

Figure 3.—Emerald ash borer infestation and quarantine map with L&N's mill locations (designated with stars) and procurement region (cross-hatched) superimposed in the northern Pennsylvania, southern New York region.

The "harvest now" behavior that some landowners will pursue is a concern for L&N as it looks to the future. This behavior will cause more ash to come on the market sooner but make ash less available a few years out. If, in the end, the EAB does not infest and kill a high proportion of the ash, the principal outcome of this preemptive harvest strategy will be to have severely distorted size and age-class distributions of the unaffected ash resource.

Ultimately, switching to other species is a strategy that could be required. Such species would include maple, of course, but other species also exist that have similar specific gravities and hardness values. Beech (*Fagus grandifolia* Ehrh.), yellow birch (*Betula alleghaniensis* Britton), and red oak (*Quercus rubra* L.) are among the top prospects. If this scenario comes to pass, it might indeed be strike three for ash baseball bats, but it will not be the end of the game for wood baseball bat manufacturers. There are more species, and more innings, left to be played.

LITERATURE CITED

Forest Products Laboratory. 1999. **Wood handbook—Wood as an engineering material.** Gen. Tech. Rep. FPL-GTR-113. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 463 p.

Glier, Ray. 2009. **MLB getting a grip on broken bats; fewer incidents in 2009.** [online]. Available: http://www.usa.today.com/sports/baseball/2009-08-03-broken-bats_N.htm (Accessed November 22, 2009).

Major League Baseball Association. 2008. **Safety tests for maple bats mandated.** [online]**.** Available: http://mlb.mlb.com/news/press_releases/press_release.jsp?ymd=20081209&content_id=3708345&vkey=pr_mlb&fext=.jsp&c_id=mlb (Accessed November 22, 2009).

New York State Department of Environmental Conservation. 2009. **Stumpage price report.** Winter 2009/#74. Albany: NY. New York State Department of Environmental Conservation. 2 p.

Sheldon, George. 2008. **Marketing the aluminum bat**. NINE: A Journal of Baseball History and Culture. 17(1):170-175.

The Pennsylvania State University. 2009. **Timber market report.** Second Quarter 2009. University Park, PA: The Pennsylvania State University. 2 p.

Wikipedia contributors. 2009. **Baseball bat.** [online]. Available**:** http://en.wikipedia.org/w/index.php?title=Baseball_bat&oldid=330675945. (Accessed December 9, 2009).